Greenville County Technical Specification for:

WQ – 09 INFILTRATION BASIN

1.0 Infiltration Basin

1.1 Description

Infiltration Basins are shallow, impounded areas designed to temporarily store and infiltrate stormwater runoff. The size and shape can vary and designs can use one large basin, or multiple smaller basins throughout a site.

By diverting stormwater runoff into the soil, the Infiltration Basin is capable of treating the water quality volume, and preserving the natural water balance. Using natural filtering properties, Infiltration Basins can remove a wide variety of pollutants from the runoff through adsorption, precipitation, filtering, and bacterial and chemical degradation.

1.2 Design

1.2.1 General Design

At a minimum, design Infiltration Basin areas to treat the first inch of runoff from all impervious areas. Infiltration Basins work best when constructed off-line, capturing only the water quality volume. Divert excess runoff away from the Infiltration Basin area or collect it with an overflow catch basin. Infiltration Basins are limited to areas with highly porous soils where the water table and or bedrock are located below the Basin bottom. Design Infiltration Basins to ensure the following:

- The maximum drainage area for any single Infiltration Basin is two (2) acres.
- The maximum ponding depth is 2 feet.
- Designed to dewater the entire water quality volume in 24-72 hours after storm event.
- Place an underdrain system above the bottom of the Infiltration Basin for all Infiltration Basin applications as many of the native soils found in Greenville County do not allow for adequate infiltration.
- An under-drain pipe is required in case clogging occurs; ensure that underdrain pipes are off line from the Infiltration Basin. Inlet must be cleared if conveyance capacity is plugged. To help with the permeability rate, a 6 inch layer of sand will be place at the bottom of the basin.
- Do not place Infiltration Basins in fill material because piping along the fill-natural ground interface may cause slope failure.
- Not intended to trap sediment during construction activities.
- Includes a sediment forebay or other pre-treatment measure such as a stabilized vegetated filter a minimum of 20-feet in length to prevent clogging in the gravel.
- Has an overflow system to provide non-erosive flow velocity along the length and at the outfall.
- Are applicable for impervious areas where there are low levels of fine particulates in the runoff and the site is completely stabilized and the potential for possible sediment loads are low.
- Basin requires a continuous, flat bottom area
- Ensure the underlying soil does not exceed 20% clay content. Ensure a texture classification report on the soil is provided.
- Infiltration rates of the underlying soils are greater than 0.5 inches per hour.

- Perform a Double-Ring test for infiltration rates.
  - The initial test elevation is at the same contour elevation as the bottom of the basin elevation; test is taken 4 ft below the proposed Infiltration Basins bottom elevation.
  - Submit supporting test documentation performed by a registered geotechnical engineer.
- Ensure field stakes from testing are clearly labeled and left in the field for inspection purposes.
- Provide at least a 5-foot setback from property lines.
- Do not install Infiltration Basins on slopes greater than 20 percent.
- Provide cleanouts every 100-feet along the infiltration practice to allow for access and maintenance.
- Provide at least a 25-foot setback down gradient from structures and dry wells.
- Located no closer than 150-feet away from all drinking water wells and 100-feet upgradient from building foundations and septic systems
  - During the design consider depth of bedrock, proximity to wells, slope, watershed, depth to water table, etc.
- Slopes in the basin are no steeper than 3H: 1V
- The bottom of the basin is located at least 2-feet above seasonal high water table.
  - **Note:** The 2-foot depth helps prevent soil compaction occurring from the weight of stored water
- Not used in an industrial or commercial area where solvents and /or petroleum are loaded, unloaded, stored or applied or pesticides are loaded, unloaded or stored
- Not used where installation creates a significant risk for basement seepage or flooding or interfere with the operation of subsurface sewage disposal systems
- To ensure success of the Infiltration Basin function; follow these steps during construction:
  1. Construct basins at the end of the development's construction and final stabilization of the site.
  2. Smearing of the soil at the interface with basin floor is avoided and/or corrected by raking or compaction rototilling.
  3. Compaction of the basin bottom during construction by construction equipment traffic is kept to a minimum.

1.2.2 Basin Surface Area

Design Infiltration Basin invert area by using the following equation: Provide the calculated area at the basin bottom/invert

$$A = \frac{DA*Rv}{kt}$$

Where:

DA	=	Contributing impervious drainage area of Infiltration Basin (feet^2)
Rv	=	Runoff volume (feet) 0.083-feet (1-inch) for Greenville County
k	=	Field measured hydraulic conductivity of filter media
t	=	Drawdown time (24-72hrs)

1.2.3 Water Draw Down Time

Design Infiltration Basin areas to fully de-water the water quality volume within a 24-hour to 72-hour period. Design the underdrain system to safely pass the peak draw down flow rate of the filter media. The general equation used to determine draw down time is Darcy's Equation:

$$Q = 2.3e^{-5}\ K\ A\frac{\Delta H}{\Delta L}$$

Where:

Q = Flow rate through Infiltration Basin (cfs)

K = Hydraulic conductivity of the filter media (in/hr) (Value varies based on actual filter media used)

A = Surface area of Infiltration Basin (feet^2)

ΔH = Maximum ponding depth above bottom of soil mix (feet)

ΔL = Depth of soil mix (feet)

Typical hydraulic conductivity values are given in Table 2.

Table 1: General Hydraulic Conductivity of Soils

Soil Classification	Hydraulic Conductivity (inches/hour)
Sand	6.0
Loamy Sand	2.0
Sandy Loam	0.5-1.0

Source: Urban Waterways / Urban Storm Water Structural Best Management Practices (BMPs), North Carolina Extension Service, June, 1999.

Determining the total draw down time is a three-step process.

1. Determine the time it takes to drain the ponded water.
   - Utilize Darcy's Equation to calculate the flow rate (cfs).
   - Calculate the total ponded water volume (feet^3) by multiplying the Infiltration Basin area (feet^2) by the ponded water depth (feet).
   - Divide the total ponded water volume (feet^3) by the flow rate (cfs) to calculate the time to drain the ponded water (seconds)
2. Determine the time it takes to drain the saturated filter media.
   - Calculate the total volume of water contained in the filter media (feet^3) by multiplying the Infiltration Basin area (feet^2) by the filter media depth (feet) by the porosity (dimensionless) of the filter media.
   - Divide the filter media water volume (feet^3) by the flow rate from Darcy's Equation (cfs) to calculate the time to drain the ponded water (seconds).
3. Add up the time to drain the ponded water with the time that it takes to drain the filter media to calculate the total Infiltration Basin area draw down time.

1.2.4 Underdrain System

Place an underdrain system beneath the filter media for **all** Infiltration Basin areas as many of the native soils found in Greenville County do not allow for adequate infiltration.

Provide an underdrain system that consists of continuous closed joint perforated plastic pipe underdrains with a minimum 4-inch diameter, an 8-inch minimum gravel filter layer, a nonwoven geotextile filter fabric to separate the gravel from the native soils and the gravel from the filter media, and minimum 4-inch diameter non-perforated PVC clean out wells.

The maximum spacing of pipe underdrain is 10 feet.

Design the under drain system to safely pass the peak draw down rate calculated in Section 1.2.3.

When applicable, connect underdrain system to overflow riser. Avoid piping underdrain below compacted berms.

Table 2: Underdrain Material Specifications

Material	Specification
Aggregate	Use course aggregate No. 57 or No. 5 consisting of crushed slag or gravel.
Pipe Underdrains	Use PVC perforated pipe (AASHTO M 252) underdrains with a minimum diameter of 4-inches.
Clean Out and Outlet Pipe	Use non-perforated pipe with a minimum diameter of 4-inches.
Nonwoven Geotextile Fabric	Use Class 2 Type C non-woven geotextile fabric.

1.2.5 Filter Media

The filter media provides a medium for physical filtration for the stormwater runoff with enough organic matter content to support provide water and nutrients for plant life.

Ensure the filter media of the Infiltration Basin area is level to allow uniform ponding over the entire area. The maximum ponding depth above the filter media is 2-feet to allow the Infiltration Basin area to drain within a reasonable time and to prevent long periods of plant submergence. Provide a filter media with a minimum infiltration rate of 1.0 in/hour and a maximum rate of 6.0 in/hr. The average porosity of the filter media is approximately 0.45. The minimum filter media depth is 3-feet.

The USDA textural classification of the filter media is Loamy Sand or Sandy Loam. The filter media is furnished, and on-site soils are not acceptable. Test the filter media to meet the following criteria:

Table 3: Filter Media Material Specifications

Item	Percent of Total Filter Media by Weight	ASTM Sieve Size	Percent Passing by Weight
Sand* Clean, Washed, Well Graded, No Organic Material *Aggregate No . FA-10* *ASTM C-33 Concrete Sand* *AASHTO M-6* *AASHTO M-43, No. 9 or No. 10*	80% Max	3/8 in.	100
		No. 4	95-100
		No. 8	80-100
		No. 16	50-85
		No. 30	25-60
		No. 50	10-30
		No. 100	2-10
		No. 200	0-3

Screened Topsoil *Loamy Sand or Sandy Loam* *ASTM D5268* *(imported or manufactured topsoil)* *Max 5% clay content*	15% Max.	2 in.	100
		1 in.	95- 100
		No. 4	75-100
		No. 10	60-100
		No. 200	10-50
		0.002 mm	0-5
Organic Matter in the form of Compost, Leaf Compost, Peat Moss or Pinebark Nursery Mix**	5% Min	3/8 in.	85-100
		No. 8	50-80
		No. 30	0-40

Do not use lime stone screenings.
****** Potting grade pine bark with no particles larger than ½ inches.***

Submit the source of the filter media and test results to the ENGINEER prior to the start of construction of Infiltration Basin areas. Do not add material to a stockpile of filter media once a stockpile has been sampled. Allow sufficient time for testing. Utilize a filter media from a certified source or laboratory to reduce mobilization time and construction delays.

Use a filter media that is uniform, free of stones, stumps, roots or other similar objects larger than two inches excluding mulch. Do not mix or dump materials or substances within the Infiltration Basin area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations.

Test the filter media to meet the criteria shown in Table 5:

Table 4: Filter Media Chemical Analysis

Item	Criteria	Test Method
Corrected pH	6.0 – 7.5	ASTM D4972
Magnesium	Minimum 32 ppm	*
P-Index	0-30	USDA Soil Test
Phosphorus (Phosphate - P_2O_5)	Not to exceed 69 ppm	*
Potassium (K_2O)	Minimum 78 ppm	*
Soluble Salts	Not to exceed 500 ppm	*

* Use authorized soil test procedures.

Should the filter media pH fall outside of the acceptable range, modify with lime (to raise pH) or iron sulfate plus sulfur (to lower pH). Uniformly mix lime or iron sulfate into the filter media prior to use in Infiltration Basin areas.

Modify the filter media with magnesium sulfate if the filter media does not meet the minimum requirement for magnesium. Modify the filter media with potash if the filter media does not meet the minimum requirement for potassium. Uniformly mix magnesium sulfate and potash into the filter media prior to use in Infiltration Basin areas.

A filter media that fails to meet the minimum requirements must be replaced.

1.2.6 Overflow System

Design an overflow system to pass runoff volumes greater than the water quality volume away from the Infiltration Basin area. Place an outflow structure at the elevation of the maximum 2-feet ponding depth above the Infiltration Basin surface to carry excess runoff to a stormwater conveyance system or stabilized outlet.

1.2.7 Pre-treatment System

Provide a pre-treatment system to reduce incoming velocities, evenly spread the flow over the entire Infiltration Basin area, and to trap coarse sediment particles before they reach the filter media. Several pre-treatment systems are applicable, depending on whether the Infiltration Basin area receives sheet flow, shallow concentrated flow or deeper concentrated flows. The following are appropriate pretreatment options:

- **Forebay** (for channel flow): Located at pipe inlets or curb cuts leading to the Infiltration Basin area consisting of energy dissipation and flow dispersion sized for the expected peak discharge rate. The Forebay may be formed by a wooden or stone check dam or an earthen or rock berm. Ensure the Forebay is protected with the proper erosion prevention measures. The Forebay does not require an underlying filter media.

- **Grass Filter Strips** (for sheet flow): Extend a minimum of 20 feet from edge of pavement to the upstream edge of the Infiltration Basin area with a maximum slope of 5%.

- **Gravel or Stone Diaphragms** (for sheet or concentrated flow): Located at the edge of pavement or other inflow point, running perpendicular to the flow path to promote settling. Size the stone according to the expected peak discharge rate.

- **Level Spreaders** (for sheet flow): Gravel, landscape stone, or concrete level spreader located along the upstream edge of the Infiltration Basin area. Level spreaders successfully reduce incoming energy from the runoff and convert concentrated flow to sheet flow that is evenly distributed across the entire Infiltration Basin area. This requires a 2 to 4 inch elevation drop from a hard-edged surface into the Infiltration Basin area.

- **Manufactured Stormwater Devices (MTDs):** An approved MTD may be used to provide pre-treatment.

1.3 Vegetation

1.3.1 Turf Grass Only

Use turfgrass species with a thick dense cover, slow growing, applicable to the expected moisture conditions (dry or wet), do not require frequent mowing, and have low nutrient requirements. The preferred method of establishing turf grass is sodding. Use temporary erosion control blankets to provide temporary cover when establishing turf grass by seeding.

1.3.2 Native Grasses and Perennials

Create a low maintenance native grass or wildflower meadow with native grasses and native perennial species. Use temporary erosion control blankets for erosion prevention. Plant native grasses and perennials of the same species in clusters 1.0 to 1.5 feet on-center.

1.4 Construction Requirements

Do not construct Infiltration Basin areas until all contributing drainage areas are stabilized as directed by the ENGINEER. Do not use Infiltration Basin areas as sediment control facilities for during construction sediment control. Do not operate heavy equipment within the perimeter of Infiltration Basin areas during excavation, underdrain placement, backfilling, planting, or mulching.

Separate Infiltration Basin areas from the water table to ensure groundwater does not enter the facility leading to groundwater contamination or Infiltration Basin failure. Ensure a vertical distance of 4 feet between the bottom of the Infiltration Basin area and the seasonally high ground water table.

1.4.1 Site Preparation

Pre-treat stormwater runoff to reduce the incoming velocities, evenly spread the flow over the entire Infiltration Basin area, and provides removal of coarse sediments. Because Infiltration Basin areas are sensitive to fine sediments, do not install them on sites where the contributing area is not completely stabilized or is periodically being disturbed.

1.4.2 Excavation

Excavate the Infiltration Basin area to the dimensions, side slopes, and elevations shown on the Plans. Excavate Infiltration Basin areas to the required depth based on the plantings utilized.

Ensure excavation minimizes the compaction of the bottom of the Infiltration Basin area. Operate excavators and backhoes on the ground adjacent to the Infiltration Basin area or use low ground-contact pressure equipment. Do not operate heavy equipment on the bottom of the Infiltration Basin area.

Remove excavated materials from the Infiltration Basin area and dispose of them properly.

1.4.3 Underdrain System

Prior to placing the underdrain system, alleviated compaction on the bottom of the Infiltration Basin area by using a primary tilling operation such as a chisel plow, ripper, or subsoiler to a depth of 12 inches. Substitute methods must be approved by the ENGINEER. Rototillers typically do not till deep enough to reduce the effects of compaction from heavy equipment.

Remove any ponded water from the bottom of the excavated area. Line the excavated area with a Class 2, Type C nonwoven geotextile fabric.

Place a layer of No. 57 Aggregate 3-foot wide, and minimum of 3-inches deep on top of the nonwoven filter fabric. Place the pipe underdrains on top of the underlying aggregate layer. Lay the underdrain pipe at a minimum 0.5 percent longitudinal slope. The perforated underdrain drain pipe may be connected to a stormwater conveyance system or stabilized outlet. Cap the ends of underdrain pipes not terminating in an observation well.

Install observation wells/cleanouts of non-perforated vertically in the Infiltration Basin area. Install observation wells and/or clean-out pipes at the ratio of one minimum per every 1000 square feet of surface area as shown on the Plans. Connect the wells/cleanouts to the perforated underdrain with the appropriate manufactured connections as shown on the Plans. Extend the wells/cleanouts 6 inches above the top elevation of the Infiltration Basin area mulch layer, and cap with a screw cap.

Place No. 57 Aggregate around the pipe underdrain system to a minimum depth of 8-inches. Place a Class 2, Type C nonwoven geotextile fabric between the boundary of the gravel and the filter media to prohibit the filter media from filtering down to the perforated pipe underdrain.

Place an outflow structure at the elevation of the maximum 9-inch to 12-inch ponding depth of the Infiltration Basin area to carry excess runoff from the Infiltration Basin area to a stormwater conveyance system, or stabilized outlet.

1.4.5 Filter Media

Place and grade the filter media using low ground-contact pressure equipment or excavators and/or backhoes operating on the ground adjacent to the Infiltration Basin area. Do not use heavy equipment within the perimeter of the Infiltration Basin area before, during, or after the placement of the filter media. Place the filter media in vertical layers with a thickness of 12 to 18 inches. Compact the filter media by saturating the entire Infiltration Basin area after each lift of filter media is placed until water flows from the underdrain system. Apply water for saturation by spraying or sprinkling. Perform saturation of each lift in the presence of the ENGINEER. Do not use equipment to compact the filter media. Use an appropriate

sediment control BMP to treat any sediment-laden water discharged from the underdrain during the settling process.

Test the installed filter media to determine the actual infiltration rate after placement. Ensure the infiltration rate is within the range of 1 to 6 inches per hour.

1.5 Inspection and Maintenance of Infiltration Basin

Regular inspection and maintenance is critical to the effective operation of Infiltration Basin areas. Maintenance responsibility of the Infiltration Basin area is vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

Records of inspections and maintenance will be provided on plans and in the SWPPP

The surface of the ponding area will become clogged with fine sediments over time. Perform core aeration and cultivate unvegetated areas as required to ensure adequate filtration. Other required maintenance includes but is not limited to:

- Perform pruning and weeding to maintain appearance periodically as needed.
- Remove trash and debris periodically as needed.

Table 5: Summary of Maintenance Requirements

Required Maintenance	Frequency
Pruning and weeding.	As needed
Remove trash and debris.	As needed
Core Aeration	Semi-annual (every 6 months)
Inspect inflow points for clogging. Remove any sediment	Semi-annual (every 6 months)
Repair eroded areas. Re-seed or sod as necessary.	Semi-annual (every 6 months)
Inspect vegetation to evaluate health.	Semi-annual (every 6 months)
Remove and replace dead or severely diseased vegetation.	Semi-annual (every 6 months)
Removal of evasive vegetation.	Semi-annual (every 6 months)
Pesticide management	Annual, or as needed
Test filter media for pH.	Annual
Apply lime if pH < 5.2.	As needed
Add iron sulfate + sulfur if pH > 8.0.	As needed